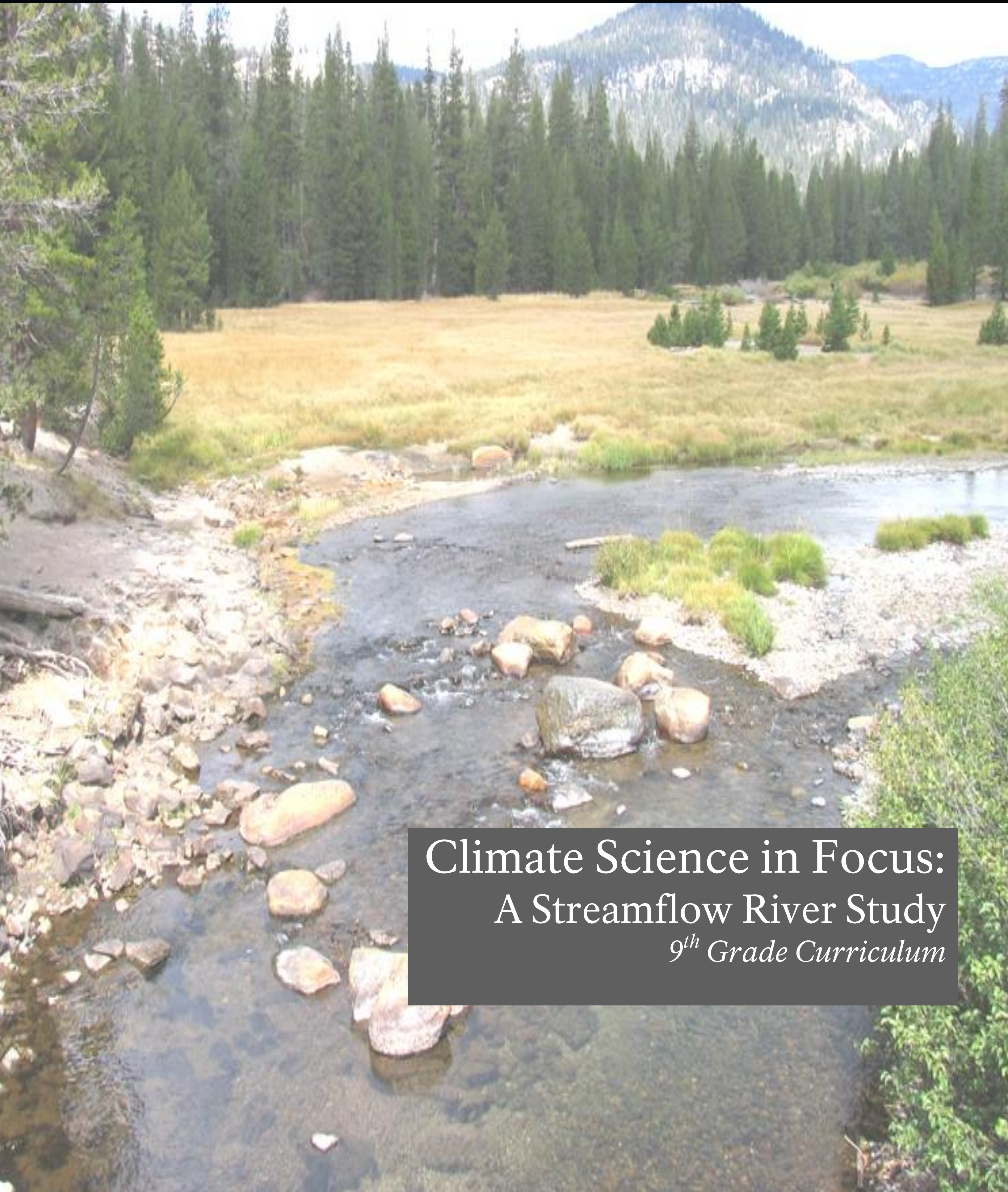
Devils Postpile National Monument
National Park Service
US. Department of the Interior



Climate Science in Focus:
A Streamflow River Study
9th Grade Curriculum

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Rationale:

The Earth consists of four systems: the atmosphere, hydrosphere, geosphere, and biosphere, which are interconnected. Changes to one part of the system can have consequences on the others. Changes to global or regional climate can be caused by changes in the sun's energy output or Earth's orbit, tectonic events, ocean circulation, volcanic activity, glaciers, vegetation, and human activity.

Water is essential for life on Earth. Relative water availability is a major factor in designating habitats for different living organisms. In the United States, things like agriculture and water rights are hot topics.

Current models predict that average global temperatures are going to continue to rise even if regional climate changes remain complex and varied. These changes will have an impact on all of Earth's systems.

Studies have shown that climate change is driven not only by natural effects but also by human activities. Knowledge of the factors that affect climate, coupled with responsible management of natural resources are required for sustaining these Earth systems. Long-term change can be anticipated using science-based predictive models making science and engineering essential to understanding global climate change and its possible impacts.

National Parks can serve as benchmarks for climate science trends and effects over time because they are protected areas void of human influence. Understanding current climate trends will help set students up to be successful in interpreting and engaging in discussions about climate change, which will lead to informed decision making.

Next Gen Science Standards:

Students who demonstrate understanding can:

HS-ESS2-2. Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.

HS-ESS2-4. Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.

HS-ESS3-1. Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.

HS-ESS3-5. Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems.

HS-ESS3-6. Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.

HS-LS2-6. Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.

HS-LS2-7. Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.

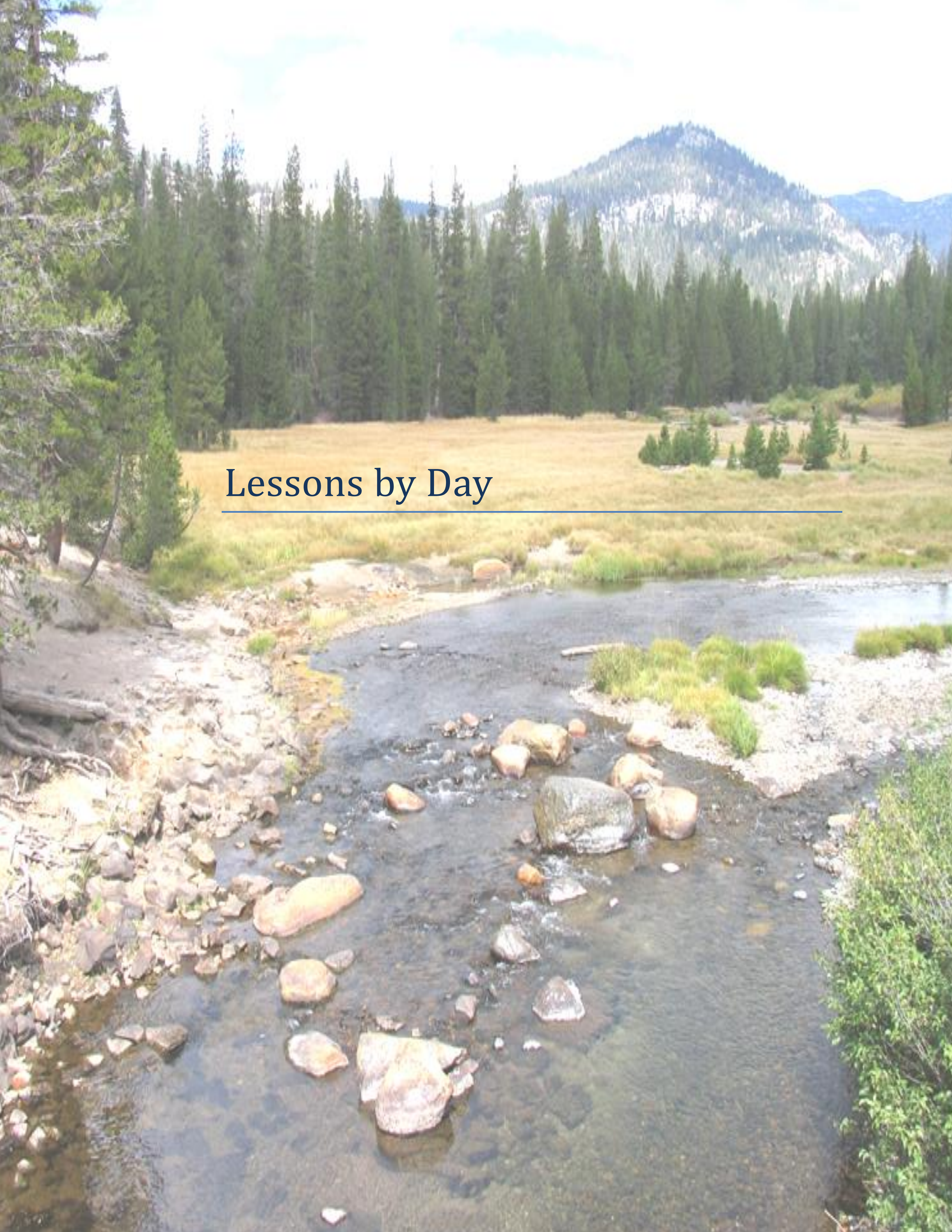
HS-LS4-6. Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.

SCIENCE AND ENGINEERING	**DISCIPLINARY CORE IDEAS**	**CROSS-CUTTING CONCEPTS**
1. Asking questions and defining problems *2. Developing and using models* *3. Planning and carrying out investigations* *4. Analyzing and interpreting data* *5. Using mathematics and computational thinking* *6. Constructing explanations and designing solutions* *7. Engaging in argument from evidence* *8. Obtaining, evaluating, and communication information*	ESS1.B: Earth and the Solar System ESS2.A: Earth Material and Systems ESS2.C: The Roles of Water in Earth's Surface Processes ESS2.D: Weather and Climate ESS3.A: Natural Resources ESS3.C: Human Impacts ESS3.D: Global Climate Change LS2.C: Ecosystem Dynamics, Functioning, and Resilience LS4.C: Adaptation	*1. Patterns* *2. Cause and Effect: Mechanism and explanation* *4. Systems and system models* *5. Energy and matter: Flows, cycles, and conservation* *7. Stability and change*

Unit Plan Outline & Standards		
Throughout the unit students will develop an understanding of climate change, how scientists study climate change, and what can be done locally to address climate change issues.		
Day 1: Earth as a System **Objective**: Students will be able to explain the Earth as a system of interconnected parts and properly define and use Earth science vocabulary.	HS-ESS3-6.	Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.
Day 2: Weather vs. Climate **Objective**: Students will be able to compare and contrast weather and climate and predict the effects of climate change on life.	HS-LS2-6.	Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.
Day 3: Watershed **Objective**: Students will be able to predict how local and regional areas could be affected by climate change and propose ways to minimize potential negative effects of climate change on water availability.	HS-ESS2-2.	Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.
Day 4: Climate Science Data and Tools **Objective**: Students will be able to predict changes that will occur to the Sierra Nevada snowpack if climate change continues and predict the changes that will result on the biosphere due to climate change.	HS-ESS2-4. HS-ESS3-1.	Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate. Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in

	climate have influenced human activity.
Day 5: On-site or Virtual Visit **Objective:** Students will be able to complete a stream assessment lab activity, record and analyze appropriate data, and report findings through an appropriate medium.	HS-ESS2-2. Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.
Day 6: National Park Service Connections **Objective**: Students will be able to give at least one example of how climate change is impacting wildlife and state why National Parks are important to climate science.	HS-ESS3-6. Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.
Day 7: Project Preparation Day 8: Presentations **Objective**: Students will be able to create a product that conveys climate change information and possible solutions.	HS-ESS3-5. Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems. HS-LS2-7. Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity. HS-LS4-6. Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.
Day 8: Assessment and Evaluation **Objective**: Students will be able to demonstrate learning through performance on post-assessment and complete Unit Evaluation.	HS-ESS3-5. Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems. HS-LS2-7. Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity. HS-LS4-6. Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.

Lessons by Day



Date:___________________
Grade(s):________________

Next Gen Science Standards:

Students who demonstrate understanding can:

HS-ESS3-6. Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.

SCIENCE AND ENGINEERING	DISCIPLINARY CORE IDEAS	CROSS-CUTTING CONCEPTS
1. Asking questions and defining problems *5. Using mathematics and computational thinking* *8. Obtaining, evaluating, and communication information*	ESS3.D: Global Climate Change	*1. Patterns* *2. Cause and Effect: Mechanism and explanation* *4. Systems and system models* *5. Energy and matter: Flows, cycles, and conservation* *7. Stability and change*

Instructional Objective(s):

Students will be able to:

1. Explain the Earth as a system of interconnected parts.
2. Properly define and use Earth science vocabulary.

Prerequisite Concepts and Skills:

Administer the pre test evaluation prior to starting unit.

Vocabulary

geosphere, hydrosphere, biosphere, atmosphere, geosciences, solar output, reflection, transmission, thermal capacity, global, geography, carbon cycle.

This lesson was created in partnership with the Teacher-Ranger-Teacher program through the National Park Service.

Date:____________________
Grade(s):_________________

Materials and Resources:

Teacher	Students
Downloaded video, *Earth as a System* http://www.teachersdomain.org/resource/ess05.sci.ess.earthsys.hologlobe/ (Alternate option is to show video directly from internet during class.)	Worksheet 1.1 – Earth as a System (one per student) (NPS provided master copy) Butcher paper/markers one set per group (Teacher provided) Post-it notes (3 per student) (Teacher provided)

Lesson Activities: 58 min

Teacher Activities	Student Activities	Time:
Introduction: 1. Display the DoNow. 2. Take attendance while students complete the DoNow. 3. Prepare to show the Earth as a System introductory video on the internet.	1. DoNow: What is a system? Define and provide an example of a system. Diagram your system.	5 min
New Content: 1. Distribute worksheet 1.1. 2. Show the video "Earth as a System" (5:31). 3. Monitor discussion and distribute butcher paper and markers for posters. 4. Distribute post-it notes and instruct students on "gallery walk." 5. Monitor progress.	1. Complete pre-video questions on worksheet 1.1 2. Watch the video "Earth as a System." Complete post-video questions on worksheet 1.1. 3. In small groups, discuss what "Earth as a system" means? 4. Create an illustration that demonstrates, "Earth as a System." Be sure to include the 4 spheres and give at least one example of how humans are impacting/influencing each one. 5. Gallery walk the posters created by all groups and make 2 positive comments and 1 suggestion on each.	5 min 10 min 8 min 15 min 10 min
Wrap-up 1. Provide exit ticket question. 2. Dismiss students.	1. Complete exit ticket and wait for dismissal. Exit ticket—How do you view the Earth differently after today's activities?	5 min

Organizational and/or Behavioral Management Strategies:

Assessment and Evaluation:

This lesson was created in partnership with the Teacher-Ranger-Teacher program through the National Park Service.

Extensions:

Adaptations:

Teacher Reflections:

This lesson was created in partnership with the Teacher-Ranger-Teacher program through the National Park Service.

Date:____________________
Grade(s):_________________

Next Gen Science Standards:		
Students who demonstrate understanding can: HS-LS2-6. Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.		
Science and Engineering	**Disciplinary Core Ideas**	**Cross-cutting Concepts**
7. Engaging in argument from evidence	LS2.C: Ecosystem Dynamics, Functioning, and Resilience	*7. Stability and Change*

Instructional Objective(s):
Students will be able to: 1. Compare and contrast weather and climate. 2. Predict the effects of climate change on life.

Prerequisite Concepts and Skills:
Vocabulary weather, climate, atmospheric circulation, climate change, feedback loops, physical process, chemical process, carrying capacity, morphological, physiological, behavioral traits, adaptation, redistribution,

Materials and Resources:

Teacher	Students
Video *Earth: Climate and Weather* http://video.nationalgeographic.com/video/science/earth-sci/climate-weather-sci/ Or use the downloaded video, *Climate vs Weather* Presentation – Animal Traits (NPS provided) Procedure 2.1 (NPS provided)	Worksheet 2.1 (NPS provided master copy)

This lesson was created in partnership with the Teacher-Ranger-Teacher program through the National Park Service.

Date:___________________
Grade(s):_________________

Lesson Activities: 58 min

Teacher Activities	Student Activities	Time:
Introduction: 1. Display the DoNow. 2. Take attendance.	1. DoNow- How do animals adapt to their climate?	5 min
New Content: 1. Display video *Earth: Climate and Weather.* 2. Monitor students as they complete a Venn diagram showing similarities and differences between weather and climate Worksheet 2.1. 3. Guide brainstorming activity. Record list or have volunteer record. 4. Lecture/Notes: Presentation to define morphological, physiological, and behavioral traits of animals. 5. Carrying capacity bucket demo. Procedure 2.1	1. Watch the video *Earth: Climate and Weather.* 2. Complete Weather/Climate Venn Diagram 3. Brainstorm: What changes can be observed during different seasons? (plants, animals, weather, water, daylight, temperature, …) 4. Record notes and participate in class discussion. 5. In three paragraphs, in your own words, describe carrying capacity. (Intro, Body, Concl.).	4 min 6 min 8 min 20 min 10 min
Wrap-up: 1. Monitor students exit ticket. 2. Dismiss students.	1. Exit ticket – Based on what you know about traits of animals, predict some of the effects of climate change on animals.	5 min

Organizational and/or Behavioral Management Strategies:

Assessment and Evaluation:

Extensions:

Adaptations:

Teacher Reflections:

Date:___________________
Grade(s):________________

Next Gen Science Standards:

Students who demonstrate understanding can:

HS-ESS2-2. Analyze geosciences data to make the claim that one change to Earth's surface can create feedback that causes changes to other Earth systems.

Science and Engineering	Disciplinary Core Ideas	Cross-cutting Concepts
4. Analyzing and interpreting data	ESS2.C: The Roles of Water in Earth's Surface Processes ESS2.A: Earth Materials and Systems ESS2.C: The Roles of Water in Earth's Surface Processes	*7. Stability and change*

Instructional Objective(s):

Students will be able to:

1. Predict how local and regional areas could be affected by climate change.
2. Propose ways to minimize potential negative effects of climate change on water availability.

Prerequisite Concepts and Skills:

Maps

Vocabulary

habitat, degradation, watershed, riparian, arable land, stream flow, peak flow

This lesson was created in partnership with the Teacher-Ranger-Teacher program through the National Park Service.

Date:____________________
Grade(s):_________________

Materials and Resources:

Teacher	Students
Video – *Power of Water Erosion* http://videos.howstuffworks.com/discovery/31883-howstuffworks-show-episode-4-power-of-water-erosion-video.htm Or show downloaded video, *Erosion* Presentation – Water Power! (NPS provided) Procedure 3.1 watershed directions (NPS provided) Watershed interactive map http://www.arcgis.com/apps/OnePane/basicviewer/index.html?appid=387531ac0c094da5b6139b890958fca6	Colored pencils, crayons, or thin-tip markers for tracing watershed. (Teacher provided) Worksheet 3.1 (NPS provided master copy)

Lesson Activities: 58 min

Teacher Activities	Student Activities	Time:
Introduction: 1. Display DoNow. 2. Take Attendance.	DoNow: How does water affect life and activities on the earth?	5 min
New Content: 1. Display *Power of Water Erosion* video and lead a discussion. *How can water affect the other Earth systems? How can changes to the hydrosphere affect the biosphere? Have students think about if there were to be more or less water in an area, how would that effect the ecosystem?* 2. Lecture/present Water Power! 3. Monitor student progress Procedure 3.1. 4. Trace several local watersheds on interactive online map to show students where water ends up.	1. Watch *Power of Water Erosion* video and participate in discussion. 2. Record notes and participate in class discussion 3. Trace watershed from Thousand Island Lakes and Lake Mary Worksheet 3.1. 4. Observe watershed tracing on interactive map.	8 min 10 min 10 min 10 min 10 min
Wrap-up: 1. Provide exit ticket question. 2. Dismiss students.	1. Complete exit ticket question and wait for dismissal. Predict the effects of climate change on water at the local, regional, and state level. Purpose ways that could help reverse its effects.	5 min

Organizational and/or Behavioral Management Strategies:

Assessment and Evaluation:

Extensions:

Glaciers are also being impacted by climate change. Extend this lesson by watching the video and discussing visible changes.
http://video.nationalgeographic.com/video/environment/global-warming-environment/glacier-melt/

Adaptations:

Teacher Reflections:

Date:___________________
Grade(s):________________

Next Gen Science Standards:		
Students who demonstrate understanding can: HS-ESS2-4. Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate. HS-ESS3-1. Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.		
SCIENCE AND ENGINEERING	**DISCIPLINARY CORE IDEAS**	**CROSS-CUTTING CONCEPTS**
2. Developing and using models *4. Analyzing and interpreting data* *5. Using mathematics and computational thinking* *6. Constructing explanations and designing solutions*	ESS2.D: Weather and Climate ESS3.A: Natural Resources ESS3.C: Human Impacts	*2. Cause and Effect: Mechanism and explanation* *4. Systems and system models* *5. Energy and matter: Flows, cycles, and conservation* *7. Stability and change*

Instructional Objective(s):

Students will be able to:

1. Predict changes that will occur to the Sierra Nevada snowpack if the climate change continues.
2. Predict changes that will result on the biosphere due to climate change.

Prerequisite Concepts and Skills:

Tables, graphs, charts, and background knowledge of Yosemite National Park.

Vocabulary

phenology, biodiversity, anthropogenic changes, snowpack, snow water equivalent, deduce, Infer, predict, pattern, temporal scale, spatial scale.

Materials and Resources:

Date:____________________
Grade(s):_________________

Teacher	Students
Video *A Way Forward: Dealing with Climate Change* http://video.nationalgeographic.com/video/environment/global-warming-environment/way-forward-climate/ Or show downloaded video, *Climate Change* Video *CA Dept of Water Resources Snow Surveying* [Note: wmv format] http://www.water.ca.gov/newsroom/video/education.cfm Procedure 4. 1 (NPS provided)	Large graph paper, i.e. butcher paper 1 per 2 students (Teacher provided) Markers 1 set per 2 students (Teacher provided) Optional: computers with Excel

Lesson Activities: 58 min

Teacher Activities	Student Activities	Time:
Introduction: 1. Display DoNow. 2. Take Attendance.	DoNow: 1. How have climate changes influenced human activities? How could Mammoth Lakes be affected if the climate continues to change?	5 min
New Content: 1. Display video – *A Way Forward.* 2. Distribute stream flow historical data, graph paper, and markers or visit computer lab for students to pull up Excel. *Snowpack is a natural water reservoir that slowly releases its water over time. This release directly impacts streams and rivers. Studying stream flow over a long period of time can show us how snowpack and streams are being affected by climate change.* 3. Monitor student's gallery walk. 4. Display video – *CA DWR snow surveying.* 5. Distribute article. Monitor student progress.	1. Watch video – *A Way Forward.* 2. Plot climate science data on large graph paper. Display your graph where instructed. 3. Gallery walk making comments and observations about climate change data. 4. Watch video – *CA DWR snow surveying.* 5. Read *Weather and Climate Monitoring at Devil's Postpile National Monument.* Write thesis sentence for this article.	7 min 18 min 6 min 3 min 14 min
Wrap-up: 1. Monitor students as they complete Exit ticket. 2. Dismiss students.	Exit ticket – Why is the Sierra Nevada snowpack important to other areas of California and the United States?	5 min

Organizational and/or Behavioral Management Strategies:

This lesson was created in partnership with the Teacher-Ranger-Teacher program through the National Park Service.

Assessment and Evaluation:

Extensions:

1997 Flood: one outlier that is easy to spot is January 1997. During this month there was a great rain on snow event that caused major flooding to Yosemite Valley and Mammoth Lakes- http://www.nps.gov/yose/photosmultimedia/floods-96-97.htm

Center for climate and energy solutions http://www.c2es.org/facts-figures/international-emissions/historical

Europe's Goldberg Glacier Melt- http://video.nationalgeographic.com/video/environment/global-warming-environment/glacier-melt/

Greenhouse Gases and Forests - http://video.nationalgeographic.com/video/environment/global-warming-environment/greenhouse-gases/

Adaptations:

Teacher Reflections:

Next Gen Science Standards:		
Students who demonstrate understanding can: HS-ESS2-2. Analyze geosciences data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.		
<u>Science and Engineering</u>	**<u>Disciplinary Core Ideas</u>**	**<u>Cross-cutting Concepts</u>**
2. Analyzing and interpreting data	ESS2.A: Earth Materials and Systems ESS2.D: Weather and Climate	*7. Stability and change*

Instructional Objective(s):
Students will be able to: 1. Complete a stream assessment lab activity. 2. Record and analyze appropriate data and report findings through an appropriate medium.

Prerequisite Concepts and Skills:
Tables, charts, graphs <u>Vocabulary</u> channel morphology, floodplain development, benthic cover, riffle zone, biomass, species richness, tolerance.

Materials and Resources:

Teacher	Students
Option 1: Schedule a field trip with Devils Postpile National Monument or your local NPS site to bring students on a hydrology program. Visit www.nps.gov to find sites in your area. **Option 2**: Take students out to a local stream for a teacher led lesson on hydrology (Procedure 5.1). Visit	Stream Flow River Study Trunk (NPS provided, except for oranges) Worksheet 5.1 (NPS provided master copy)

www.nps.gov/DEPO for information on having the equipment mailed to you. **Option 3:** Schedule a ranger from Devils Postpile National Monument to come into your classroom to discuss hydrology. **Option 4**: Set up a virtual lesson with Devils Postpile National Monument or another NPS site to bring a lesson on hydrology into the classroom. Contact Devils Postpile National Monument for further information. Procedure 5. 1 (NPS provided master copy)	

Lesson Activities: 58 min

Teacher Activities	Student Activities	Time:
Introduction: 1. Display DoNow. 2. Take attendance. *If time allows, display hydrology podcast	1. DoNow: Why would scientists want to know the flow-rate of particular streams and rivers? *Watch podcasts on how scientists study hydrology.	5 min *5 min
New Content: 1. Instruct students on how to travel to the stream assessment site. 2. Monitor students safety during travel. 3. Monitor students as they take stream assessment readings, procedure 5.1.	1. Walk or ride to the stream assessment location. 2. Follow instructions to perform stream assessment. Record data and observations on worksheet 5.1. 3. Return to school.	10 min 30 min 10 min
Wrap-up: 1. Assign post-lab questions and write-up for homework. 2. Dismiss students.		3 min

Organizational and/or Behavioral Management Strategies:

Assessment and Evaluation:

Extensions:

Adaptations:

Teacher Reflections:

Date:___________________
Grade(s):________________

Next Gen Science Standards:		
Students who demonstrate understanding can: HS-ESS3-6. Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.		
SCIENCE AND ENGINEERING	**DISCIPLINARY CORE IDEAS**	**CROSS-CUTTING CONCEPTS**
5. Using mathematics and computational thinking *6. Constructing explanations and designing solutions*	ESS3.C: Human Impacts ESS3.D: Global Climate Change	*4. Systems and system models* *7. Stability and change*

Instructional Objective(s):

Students will be able to:

1. Give at least one example of how climate change is impacting wildlife.
2. State why National Parks are important to climate science.

Prerequisite Concepts and Skills:

Prerequisite Concepts

National Park Service background information

Vocabulary

thermoregulation, greenhouse effect, biological extinction, model, local, regional, renewable resources, nonrenewable resources, irreplaceable resources,

Materials and Resources:

Teacher	Students
Skype/Facetime/Google+ hangout with webcam Procedure 6.1 (NPS provided)	

Lesson Activities: 58 min

This lesson was created in partnership with the Teacher-Ranger-Teacher program through the National Park Service.

Date:___________________
Grade(s):________________

Teacher Activities	Student Activities	Time:
Introduction: 1. Display DoNow. 2. Take Attendance.	1. DoNow – Describe some ways animals will respond to climate change.	5 min
New Content: 1. Display a video: Options: 1. See if the park giving the virtual lesson has a podcast for you to watch. 2. Show a podcast from the list in extensions. 2. Monitor student progress. 3. Guide students in creating questions for skype session. 4. Set up video chat with NPS.	1. Watch the video *Pika in Peril*. 2. Discuss the video as a class. 3. With a partner, write 5 questions about the climate science being studied at a National Park. 4. Ask questions and record answers with NPS staff via video chat.	5 min 5 min 10 min 30 min
Wrap-up: 1. Monitor students as they complete exit tickets. 2. Dismiss students.	Exit ticket – Why are National Parks important to climate science and why is climate science important to the National Park Service?	3 min

Organizational and/or Behavioral Management Strategies:

Assessment and Evaluation:

Extensions:

If you aren't able to schedule a virtual field trip, play NPS podcasts or videos on climate change instead.
Video—*Great Smokey Mountains National Park: Phenology and Citizen Science*
http://nature.nps.gov/multimedia/CCRP_Phenology1/index.cfm
Podcast—*Devils Postpile National Monument :Cold Air Pooling*
http://www.nps.gov/depo/photosmultimedia/videos.htm
Video—*Rocky Mountains National* Park: *Pika in Peril*
http://video.nationalgeographic.com/video/news/animals-news/pika-in-peril-missions-wcvin/

Adaptations:

Teacher Reflections:

Date:___________________
Grade(s):________________

Next Gen Science Standards:

Students who demonstrate understanding can:

HS-ESS3-5. Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems.

HS-LS2-7. Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.

HS-LS4-6. Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.

Science and Engineering	**Disciplinary Core Ideas**	**Cross-cutting Concepts**
3. Planning and carrying out investigations *4. Analyzing and interpreting data* *5. Using mathematics and computational thinking* *6. Constructing explanations and designing solutions*	ESS3.D: Global Climate Change LS2.C: Ecosystem Dynamics, Functioning, and Resilience LS4.C: Adaptation	*2. Cause and Effect: Mechanism and explanation* *7. Stability and change*

Instructional Objective(s):

Students will be able to:

1. Create a product that conveys climate change information and possible solutions.

Prerequisite Concepts and Skills:

None

This lesson was created in partnership with the Teacher-Ranger-Teacher program through the National Park Service.

Materials and Resources:

Teacher	Students
Project assignment sheet (NPS provided) Rubric (NPS provided)	Computer access

Lesson Activities: 58 min **Depending on how deeply you would like to explore the activities of the lesson, this lesson could take anywhere between one and three 58 minute sessions for all students to have a chance to present their projects.*

Lesson Activities: 58 min

Teacher Activities	Student Activities	Time:
Introduction: 1. Distribute Assignment. 2. Take attendance.	DoNow: Quietly read through the assignment and decide what type of project you will complete.	5 min
New Content: 1. Monitor students as they work on their projects either individually or in groups.	1. Complete project paying attention to requirements and guidelines.	50 min
Wrap-up: 1. Assign the completion of the project for homework. 2. Dismiss students.	1. Prepare for dismissal.	3 min

Organizational and/or Behavioral Management Strategies:

Assessment and Evaluation:

Extensions:

Adaptations:

Teacher Reflections:

Earth Science | Date:____________________
Day 8: Evaluations | Grade(s):________________

Next Gen Science Standards:

Students who demonstrate understanding can:

HS-ESS3-5. Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems.

HS-LS2-7. Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.

HS-LS4-6. Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.

Science and Engineering	Disciplinary Core Ideas	Cross-cutting Concepts
4. Analyzing and interpreting data *5. Using mathematics and computational thinking* *6. Constructing explanations and designing solutions*	ESS3.D: Global Climate Change LS2.C: Ecosystem Dynamics, Functioning, and Resilience LS4.C: Adaptation	*2. Cause and Effect: Mechanism and explanation* *7. Stability and change*

Instructional Objective(s):

Students will be able to:

1. Demonstrate learning through performance on post-assessment.
2. Complete Unit Evaluation.

Prerequisite Concepts and Skills:

None

This lesson was created in partnership with the Teacher-Ranger-Teacher program through the National Park Service.

Earth Science | Date:___________________
Day 8: Evaluations | Grade(s):________________

Materials and Resources:

Teacher	Students
	Assessment (NPS provided master copy) Unit Evaluation (NPS provided master copy)

Lesson Activities: 58 min

Teacher Activities	Student Activities	Time:
Introduction: 1. Instruct students to clear desks of all non-essential items for assessment. 2. Take attendance.	1. Prepare for assessment.	3 min
New Content: 1. Distribute assessment. 2. Monitor student progress.	1. Follow teacher instructions and complete assessment.	45 min
Wrap-up: 1. Collect assessments. 2. Distribute evaluations. 3. Dismiss students.	1. Turn in completed assessments. 2. Complete unit evaluation.	2 min 8 min

Organizational and/or Behavioral Management Strategies:

Assessment and Evaluation:

Extensions:

Adaptations:

Teacher Reflections:

Teacher Resources

Earth Science
Climate Change Pre-Assessment

Name_______________Date___________________

Pre-Assessment

1. Global warming is
    a. an increase in the average global temperature.
    b. a myth.
    c. caused by a decrease in atmospheric concentration of greenhouse gasses.
    d. irreversible.

2. One possible cause of global warming over the past 100 years is
    a. an increase in solar output.
    b. an increase in volcanic activity.
    c. an increase in burning of fossil fuels.
    d. an increase in land area covered by forests.

3. In California, most fresh water available during summer months for irrigation and human usage comes from
    a. monsoonal rain storms.
    b. snowmelt in the Sierra Nevada mountain range.
    c. the Colorado River.
    d. desalination of ocean water.

4. Stream flow measures
    a. the volume of water that passes a given point in one second.
    b. how many species of fish can be found in a given area of a stream.
    c. the amount of trash that flows into the watershed.
    d. how fast water is moving at a given point in a stream.

5. The amount of water stored in snow is called
    a. snowpack.
    b. the summer water reserve.
    c. Sierra cement.
    d. snow-water equivalent.

6. The atmospheric conditions at a given place and time are called
    a. climate.
    b. temperature.
    c. weather.
    d. clouds.

7. Most of the CO_2 emitted into the atmosphere is due to
    a. natural processes.
    b. burning of fossil fuels.
    c. deforestation.
    d. agriculture industry.

This lesson was created in partnership with the Teacher-Ranger-Teacher program through the National Park Service.

8. Since the industrial revolution, most of the increase in CO_2 concentration in the atmosphere is due to
    a. natural processes.
    b. burning of fossil fuels.
    c. deforestation.
    d. agriculture industry.

9. If California's average winter temperature continues to warm, what is a potential consequence?
    a. Mammoth Mountain Ski Area will close.
    b. Glacial coverage in the Sierra Nevada mountain range will increase.
    c. Water available during the summer for agriculture in the Central Valley will increase due to winter storms bringing rain instead of snow.
    d. The snowfall season in the Sierra Nevada mountain range will be shorter, limiting the amount of water available for the rest of California.

Countries with the highest CO_2 emissions

Country	CO2 emissions per year (10^6 Tons) (2006)	Percentage of global total	Avg. emission per km^2 of its land (tons)	CO2 emissions per year (Tons per person) (2007)
China	6,103	21.5%	636	4.9
United States	5,752	20.2%	597	19.3
Russia	1,564	5.5%	91	11.6
India	1,510	5.3%	459	1.4
Japan	1,293	4.6%	3421	9.8
Germany	805	2.8%	2254	9.6
United Kingdom	568	2.0%	2338	8.9
Canada	544	1.9%	54	16.5
South Korea	475	1.7%	4758	10.5
Italy	474	1.7%	1573	7.7

10. According to the chart above, the country with the highest CO_2 emissions per km^2 of land area is
    a. United States
    b. China
    c. South Korea
    d. United Kingdom

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11. According to the chart above, the country with the highest total CO_2 emissions is
    a. United States
    b. China
    c. South Korea
    d. United Kingdom

12. According to the chart above, the country with the highest CO_2 emissions per person is
    a. United States
    b. China
    c. South Korea
    d. United Kingdom

13. What is one possible effect of local warming on migration patterns?
    a. Migrating animals will begin their migration earlier in the spring.
    b. Migrating animals will become extinct.
    c. Migrating animals will move to lower elevations during the summer where the temperature is warmer.
    d. Migrating animals will stop their migration altogether.

Earth Science Name___________________________ Date__________
Worksheet 1.1 – Earth as a System

Earth as a System

Pre-video questions

1. How is the Earth unique among the other planets in our solar system?

Define each term

2. Biosphere – ____
3. Geosphere – ____
4. Atmosphere – ____
5. Hydrosphere – ____

Post-video questions

6. What does "geologically active planet" mean?

7. What is the source of the earth's energy?

8. How does the hydrosphere influence weather?

9. What is the difference between highlands and lowlands?

10. The earth's crust is divided into ________________.

11. Oceanic plates are being forced ________________ continental plates. This cause the _______________ plate to _____________.

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12. Where do most volcanoes and earthquakes occur?

13. How do weather and climate affect the biosphere?

14. In a paragraph, describe how the atmosphere, biosphere, geosphere, and hydrosphere all interact to make up the planet we inhabit.

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Carrying Capacity Procedure

Background
Carrying capacity is the number of living things, plants and animals, which can be supported by an area of land or water at one time. Carrying capacity is usually limited by some aspect of a species' habitat requirements. In a particular area, only a certain amount of individuals will successfully get everything that they need in order to survive.

The birth rate of a particular animal will grow exponentially until the carrying capacity is reached. The carrying capacity therefore helps keep a species in check because a population can only get so large before individuals start to die off.

Procedure
Show the students an empty bucket that represents a particular piece of land. The water that you put in the bucket represents the living organisms that live on that land. Once the bucket is full, it has reached its carrying capacity. Additional organisms would have to find a different piece of land to insure that they can get everything that they need to survive (food, water, shelter, and space).

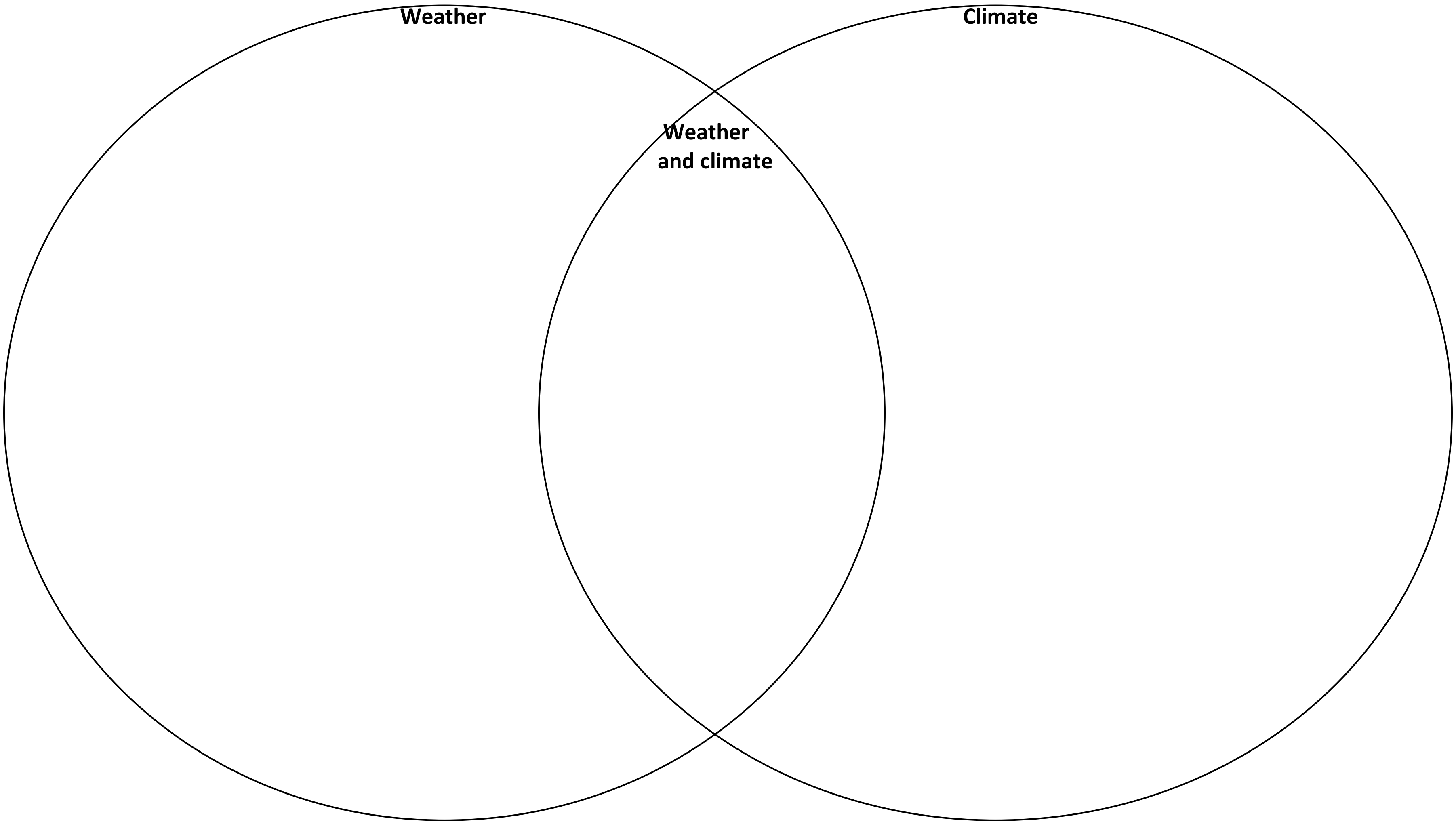
Brainstorm with the group different ecosystems and their characteristics. Link ecosystems back to climate. Climate plays a big role in the ecosystem—the plants and animals found in a certain ecosystem are adapted to the temperatures, moisture, etc.

How are changes in climate going to affect ecosystems? What sort of changes might we see as we move into the future as climate change continues? Will the same animals be able to continue living in their same ecosystems even if the climate changes?

Extension
Show the Pikas in Peril video to show how we are already starting to see impacts that climate change is having on sensitive species, such as the pika.

Earth Science
Worksheet 2.1—Weather vs. Climate

Name____________________ Date_________



This lesson was created in partnership with the Teacher-Ranger-Teacher program through the National Park Service.

Watershed Activity Procedure

Background Information

The areas in and around Mammoth Lakes have a unique hydrologic story. Due to the topography of the Eastern Sierra Mountains, water either ends up traveling west towards the San Francisco Bay or east to Los Angeles. The hydrologic divide, which can be seen at the Minaret Vista, is the imaginary line that separates the two flows. Water that falls in the town of Mammoth Lakes goes east while water that falls in Devils Postpile National Monument heads west.

The middle fork of the San Joaquin River (SJR) starts at Thousand Island Lake and continues south where it passes through Devils Postpile National Monument. Later the middle fork converges with the north and south forks continuing roughly northwest to the Central Valley. Most of the surface water in the upper (SJR) is stored and diverted at Millerton Lakes' Friant Dam, near Fresno. From Friant Dam, water is pumped north through the Madera Canal and south through the Friant-Kern canal to irrigation districts and other water retailers, which then delivers the water to end users in the southern portion of the watershed. Water flowing in the (SJR) rarely ends up all the way to the San Francisco Bay because there is such a need in the Central Valley, specifically for crop irrigation. The 400-mile-long Central Valley supplies fully one-quarter of the food that America eats.

Water that falls into the Owens River draining into Crowley Lake flows through Owens Valley, the arid basin between the eastern slope of the Sierra Nevada and the Inyo and White Mountains. The Owens Valley watershed consists of several sub-watersheds (Mono Basin, Upper Owens, Owens Gorge, Middle Owens, Lower Owens, and Owens Lake). The river, until recently, terminated at Owens Lake due to the diversion of the LA aqueduct to Los Angeles to help provide essential drinking water to southern California residences. The first LA aqueduct was completed in 1913 and the second in 1970. In winter 2006, the Los Angeles Department of Water and Power restored 5% of the pre-aqueduct flow to the river, by court order, allowing the Owens River Gorge, the river bed in the valley, and Owens Lake to contain a small amount of water.

Both watersheds are essential not only to the residences of Mammoth Lakes or to California as a whole, but to the entire United States because of its agricultural purpose. Both watersheds are also examples of things that can go wrong when all or most of the water is depleted. Devastation especially to fish and amphibian populations are two of the many side effects that can be observed from water diversion. Wetlands provide many natural services from a rest spot for migratory birds to acting as a sponge, cleaning river water as it flows by. Humans should strive to find a balance between meeting the needs of the people and of the habitat so that neither one suffers.

Procedure

Encourage students to use additional maps and resources to label as many points on the map that they can. By connecting the pictures of mountains together, they create the hydrologic divide. Have them highlight this line using a marker or highlighter.

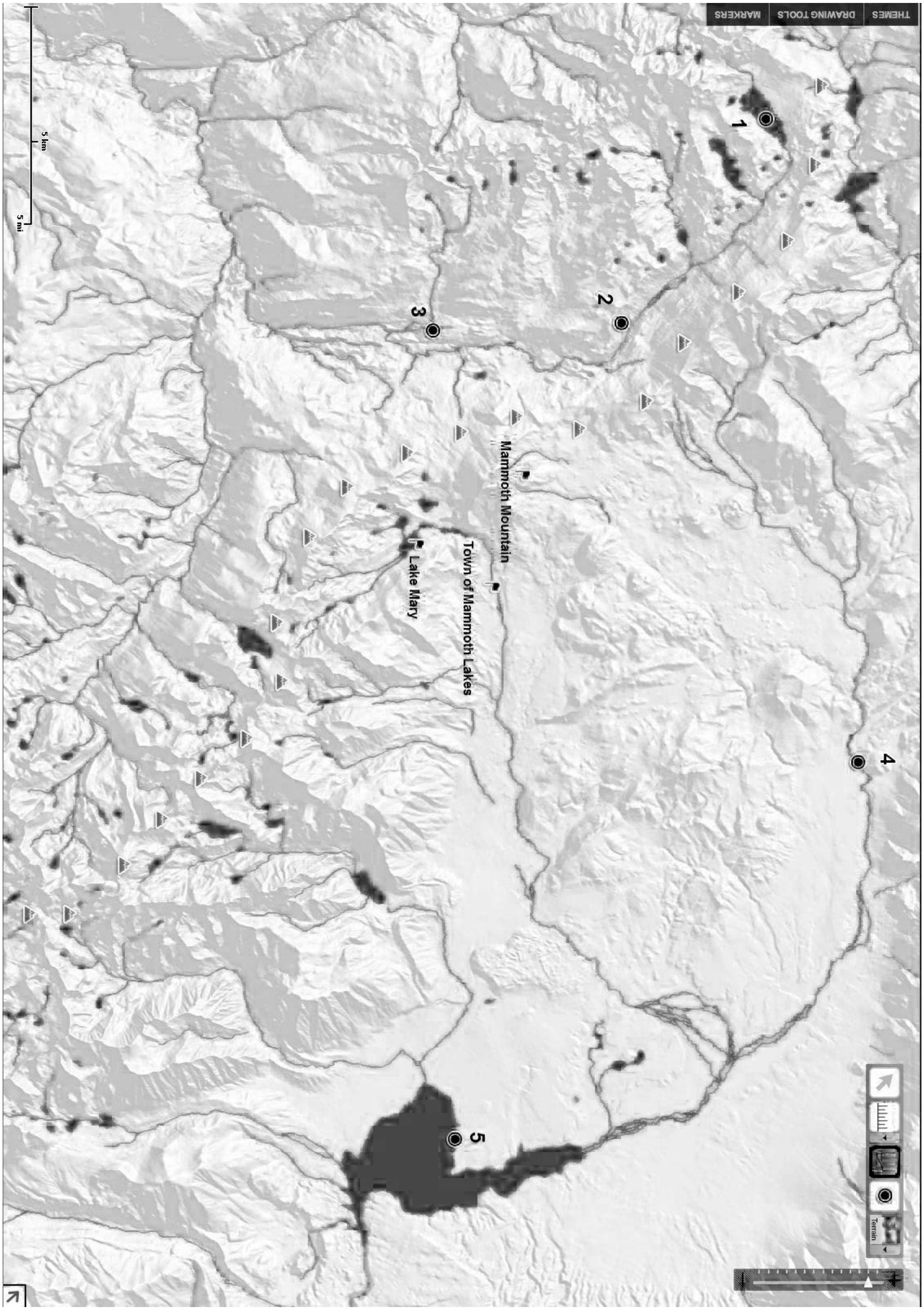
Point Labels:

1. Thousand Island Lake
2. Devils Postpile National Monument
3. Middle Fork of the San Joaquin River
4. Owens River
5. Crowley Lake

After labeling all points and tracing the hydrologic divide, students will be able to see the two watersheds in this area and understand where each one flows to.

Earth Science Name__________________________ Date__________

Worksheet 3.1—Watershed Activity



This unit was created in partnership with the Teacher-Ranger-Teacher program through the National Park Service.

Historic Stream Flow Data Procedure

This data is from 1960-2013 from Pohono Bridge in Yosemite Valley.

Optional activities for the data include having students graph in Excel, identify the months with the highest average stream flow, look for outliers/abnormalities, identify the year with the highest total stream flow, find patterns and trends, and make predictions/hypothesis about why the trends exists or what could happen in the future.

Use the Excel spreadsheet labeled 'Stream Flow Data' to find the monthly averages and example graphs.

Sequoia-Kings Canyon Stream Flow Data

	1960	**1961**	**1962**	**1963**	**1964**	**1965**	**1966**	**1967**
January	2	0.4	3	135	1	157	27	139
February	27	1	117	383	1	81	25	140
March	61	13	49	90	24	76	81	227
April	183	88	422	212	130	205	220	250
May	236	120	368	528	270	359	265	774
June	116	64	447	517	196	456	102	885
July	2	1	109	232	14	218	24	740
August	1	5	2	22	3	50	20	203
September	2	4	2	2	9	10	12	61
October	1	1	3	2	11	10	11	10
November	2	1	1	29	19	51	46	17
December	2	1	3	2	184	29	732	18

1968	**1969**	**1970**	**1971**	**1972**	**1973**	**1974**	**1975**	**1976**
25	462	168	40	18	20	98	18	15
48	274	63	33	19	59	42	30	17
69	294	103	72	83	94	181	71	33
156	546	151	131	92	245	257	80	64
259	1178	450	243	157	858	567	545	171
141	1087	269	302	77	715	516	550	27
25	672	48	66	16	161	101	96	18
21	183	17	18	11	23	23	17	17
12	22	12	12	15	13	14	11	45
27	21	11	13	18	12	14	30	13
15	14	30	15	12	31	18	12	12
23	27	25	20	18	25	15	16	10

1977	**1978**	**1979**	**1980**	**1981**	**1982**	**1983**	**1984**	**1985**
14	80	40	528	17	74	202	107	30
17	158	53	430	33	131	316	98	41
22	272	31	292	53	169	413	151	69
68	283	211	465	209	630	284	209	323
79	665	555	513	297	675	811	537	395
98	869	299	765	176	558	1271	226	232
17	426	56	501	17	336	786	99	24
17	94	17	101	16	79	354	22	14
9	123	12	7	11	157	73	10	9
12	12	29	13	12	125	19	15	11
11	11	12	12	38	145	137	51	25
72	12	17	16	32	215	192	20	88

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Earth Science
Worksheet 4.2 –Yosemite Stream Flow Data

1986	1987	1988	1989	1990	1991	1992	1993	1994
81	16	39	18	17	17	17	87	17
489	31	24	24	19	17	27	59	25
504	42	62	110	55	180	34	189	67
391	195	115	255	123	198	170	278	147
645	210	193	206	140	341	160	581	267
610	84	93	107	76	402	36	504	160
228	16	17	16	17	106	19	198	18
42	16	22	17	14	26	17	40	15
13	13	13	26	9	15	10	12	11
18	12	10	16	10	18	27	11	13
13	13	15	13	11	16	15	11	14
13	22	15	12	12	13	12	11	47

1995	1996	1997	1998	1999	2000	2001	2002	2003
99	44	743	58	21	27	16	53	45
93	268	267	167	64	73	21	45	47
301	211	267	199	94	149	112	90	133
291	367	327	334	164	269	212	267	195
545	625	580	477	354	499	439	342	539
883	449	357	978	181	256	93	243	414
676	113	132	783	30	29	23	32	60
157	21	36	154	13	17	16	18	20
23	12	15	52	11	20	12	15	12
11	12	13	12	13	31	12	14	12
11	107	17	16	13	12	40	236	12
30	187	26	17	12	12	55	22	12

2004	2005	2006	2007	2008	2009	2010	2011	2012
25	27	0	16	0	19	19	0	24
18	0	0	17	0	0	24	0	17
0	0	0	27	0	0	0	0	28
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
31	0	0	23	0	0	0	0	26
16	0	0	17	23	24	0	0	19
14	17	17	14	19	19	18	0	22
12	12	23	13	14	14	22	0	13
12	13	12	15	17	15	0	37	no data
12	12	12	14	13	17	0	0	no data
12	15	13	22	14	16	0	34	no data

Note: Data ends after September 2012

Earth Science
Worksheet 4.2 –Yosemite Stream Flow Data

Yosemite Stream Flow Data

	1960	1961	1962	1963	1964	1965	1966	1967
Jan	26	42	67	127	98	556	150	231
Feb	107	114	249	1001	114	427	144	232
March	359	183	229	345	174	474	462	631
April	1137	786	1826	575	679	1030	1568	488
May	1449	1003	2015	2519	1442	2410	1888	2807
June	788	631	2355	2478	984	2553	564	4239
July	147	115	661	898	218	1140	153	2533
August	40	67	125	185	63	409	80	518
Sept	19	26	39	68	23	91	22	156
Oct	19	20	53	47	17	41	17	58
Nov	43	25	32	238	114	211	95	44
Dec	69	62	36	157	1348	166	493	76

1968	1969	1970	1971	1972	1973	1974	1975	1976
96	493	580	257	140	189	411	106	57
268	338	380	309	161	203	267	152	79
325	409	528	379	715	240	535	290	196
868	1624	805	860	744	1001	966	361	385
1289	5305	2224	1771	1762	3711	3229	2799	911
619	4052	1501	2035	1209	2256	2330	3389	240
115	1587	395	570	196	398	535	712	93
44	316	80	117	49	187	195	127	55
18	83	29	40	158	34	42	67	86
25	127	18	25	69	44	31	211	40
214	122	103	87	104	508	42	184	21
135	212	212	127	193	304	69	94	15

1977	1978	1979	1980	1981	1982	1983	1984	1985
17	222	303	967	53	327	358	522	136
28	244	215	666	175	934	411	412	168
52	603	457	527	212	647	625	697	260
343	928	948	1411	1009	2136	595	1207	1394
379	3196	3341	2644	1668	3858	3223	2939	1747
537	4039	1746	3012	841	3031	6308	1518	687
69	1724	390	1549	148	1476	3460	595	161
15	396	94	288	39	427	1045	170	59
7	426	36	79	21	358	322	83	57
6	64	78	43	52	436	204	82	114
16	52	107	42	327	418	573	182	97
132	85	117	57	304	379	672	152	211

Earth Science
Worksheet 4.2 –Yosemite Stream Flow Data

1986	1987	1988	1989	1990	1991	1992	1993	1994
316	28	171	89	74	18	73	240	37
1035	72	239	150	105	21	172	232	61
1459	163	474	691	409	225	290	723	274
1724	1012	881	1623	1103	626	1185	1405	787
3129	1127	1115	1535	901	1690	1165	3713	1188
2743	430	640	943	558	1674	386	2932	554
682	94	189	190	239	370	316	1109	97
185	36	63	56	44	52	51	220	26
65	23	33	69	20	27	30	66	12
53	49	14	103	18	26	19	33	87
30	171	31	86	19	98	66	27	197
26	116	59	83	17	58	70	35	179

1995	1996	1997	1998	1999	2000	2001	2002	2003
379	225	2461	175	174	90	45	228	264
445	775	557	284	310	217	85	237	277
1017	760	936	615	378	420	526	380	508
1439	1706	1637	1023	919	1497	1033	1639	866
3067	3126	2922	2096	2948	2997	2348	2091	2724
4822	1897	1511	4699	1928	1874	431	1243	2209
3398	636	426	3110	403	325	130	205	361
783	156	137	531	95	31	36	40	121
203	49	54	234	46	44	20	22	46
57	32	29	76	25	29	14	16	20
35	356	32	99	31	45	90	246	27
152	514	65	156	26	43	185	112	137

2004	2005	2006	2007	2008	2009	2010	2011	2012
175	315	557	75	73	309	158	515	81
195	364	506	145	147	328	219	461	109
1035	636	578	529	444	715	460	658	275
1549	1163	1456	891	1164	1573	970	1702	1332
1621	4411	4771	1103	2222	3074	2022	2983	1396
785	3467	3682	300	1227	1228	3460	4433	344
186	1463	1113	81	270	400	965	2231	94
45	232	180	29	40	72	121	473	64
19	59	62	24	15	27	36	153	22
76	39	40	17	15	226	335	184	16
168	48	44	17	198	62	323	69	43
142	408	56	22	77	80	625	41	300

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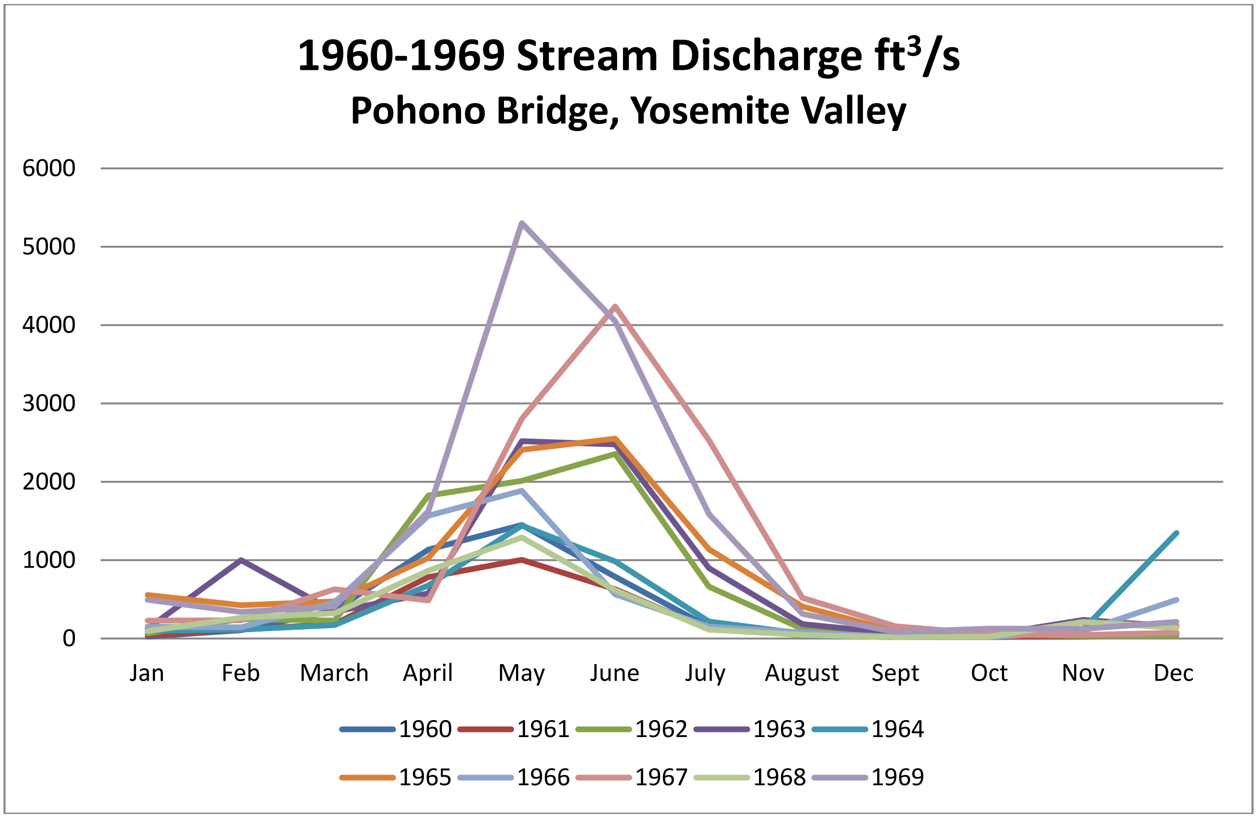

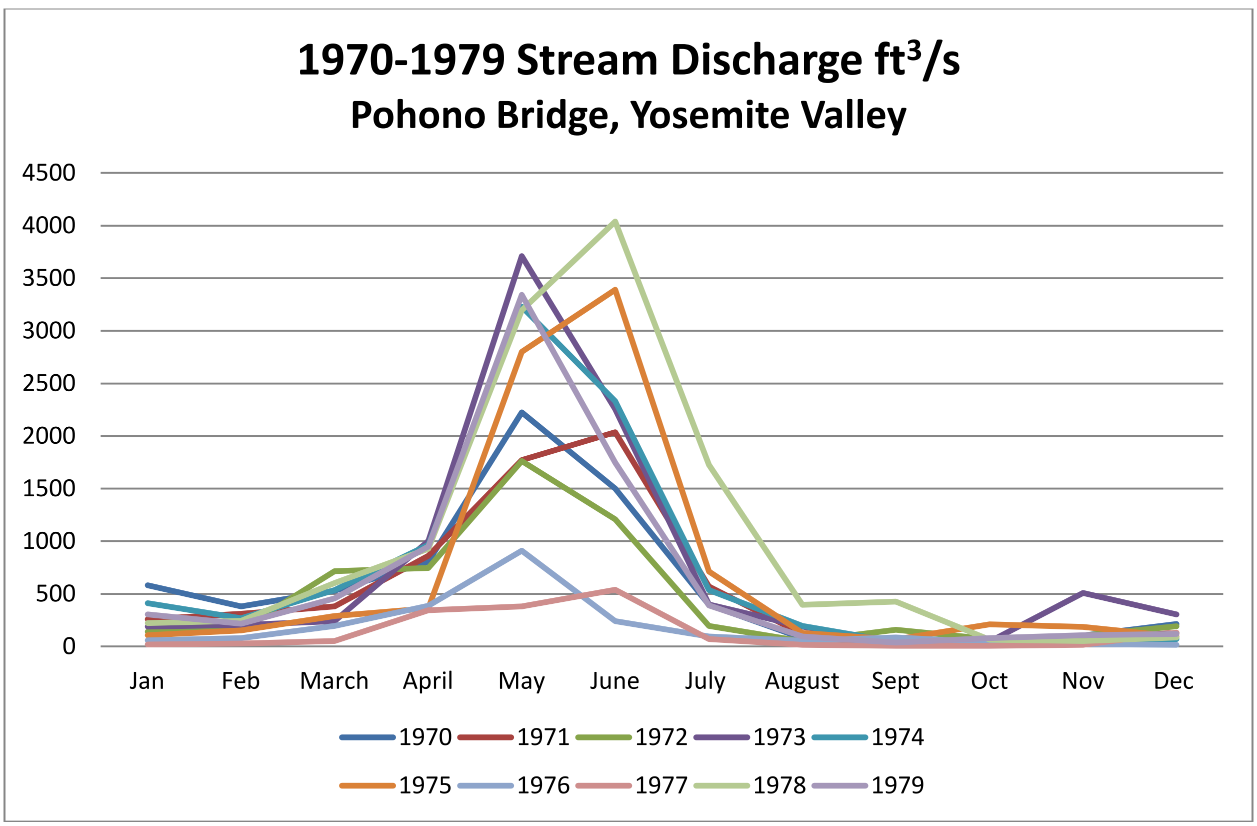

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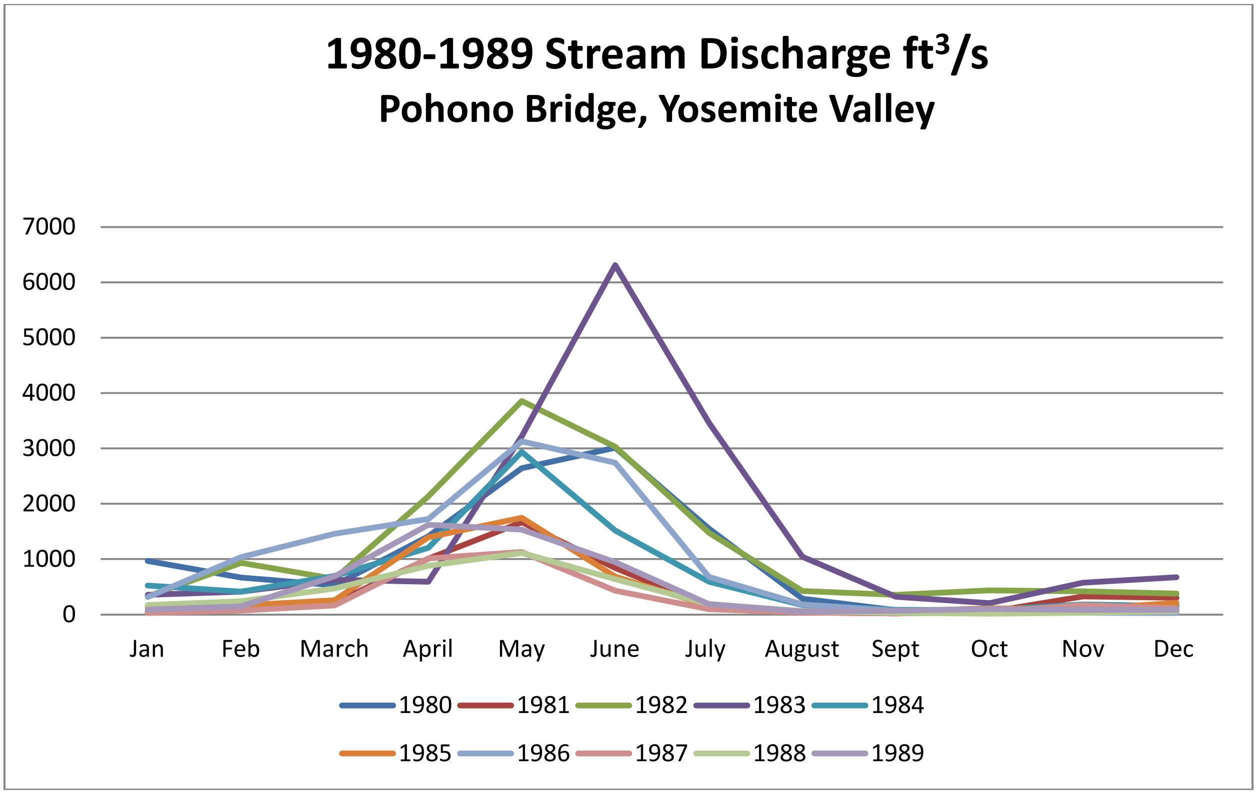
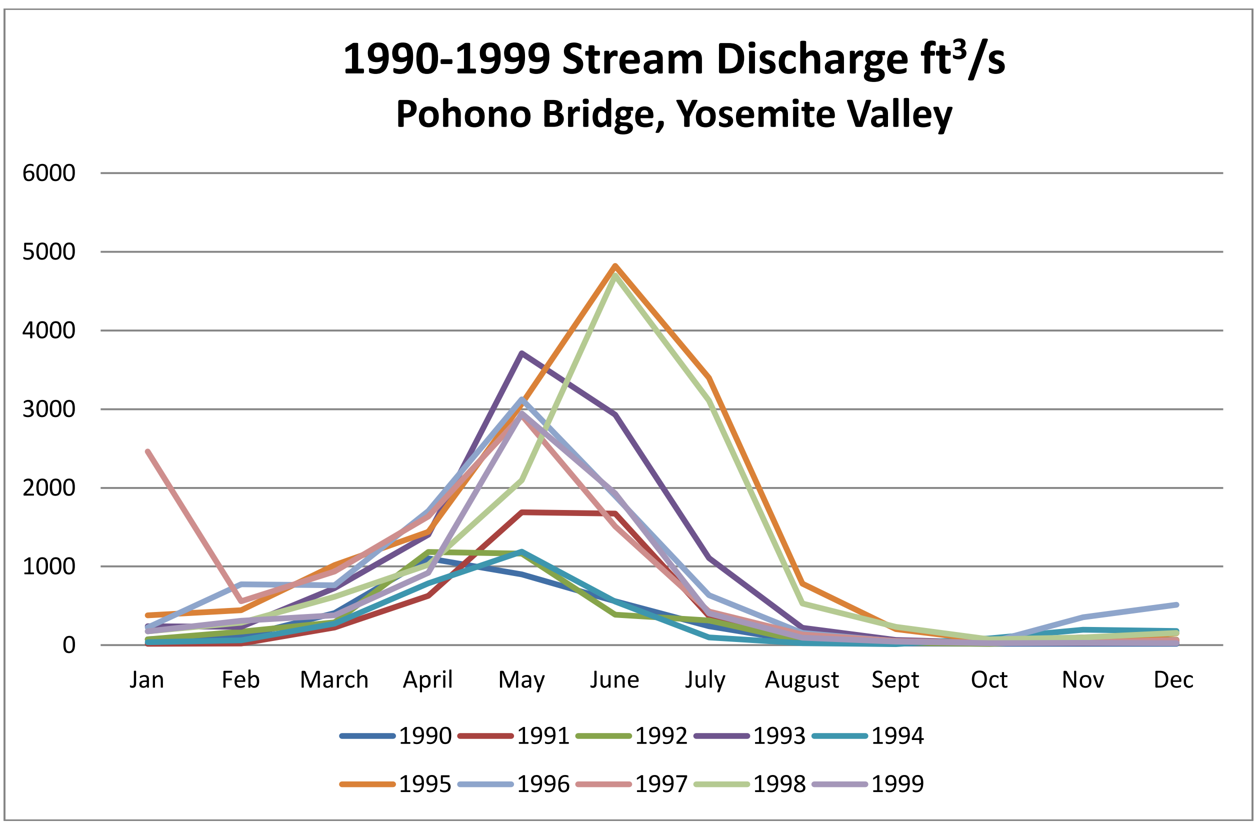

1980-1989 Stream Discharge ft³/s
Pohono Bridge, Yosemite Valley
7000
6000
5000
4000
3000
2000
1000
0
Jan
Feb
March
April
May
June
July
August
Sept
Oct
Nov
Dec
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989


1990-1999 Stream Discharge ft³/s
Pohono Bridge, Yosemite Valley
6000
5000
4000
3000
2000
1000
0
Jan
Feb
March
April
May
June
July
August
Sept
Oct
Nov
Dec
1990
1991
1992
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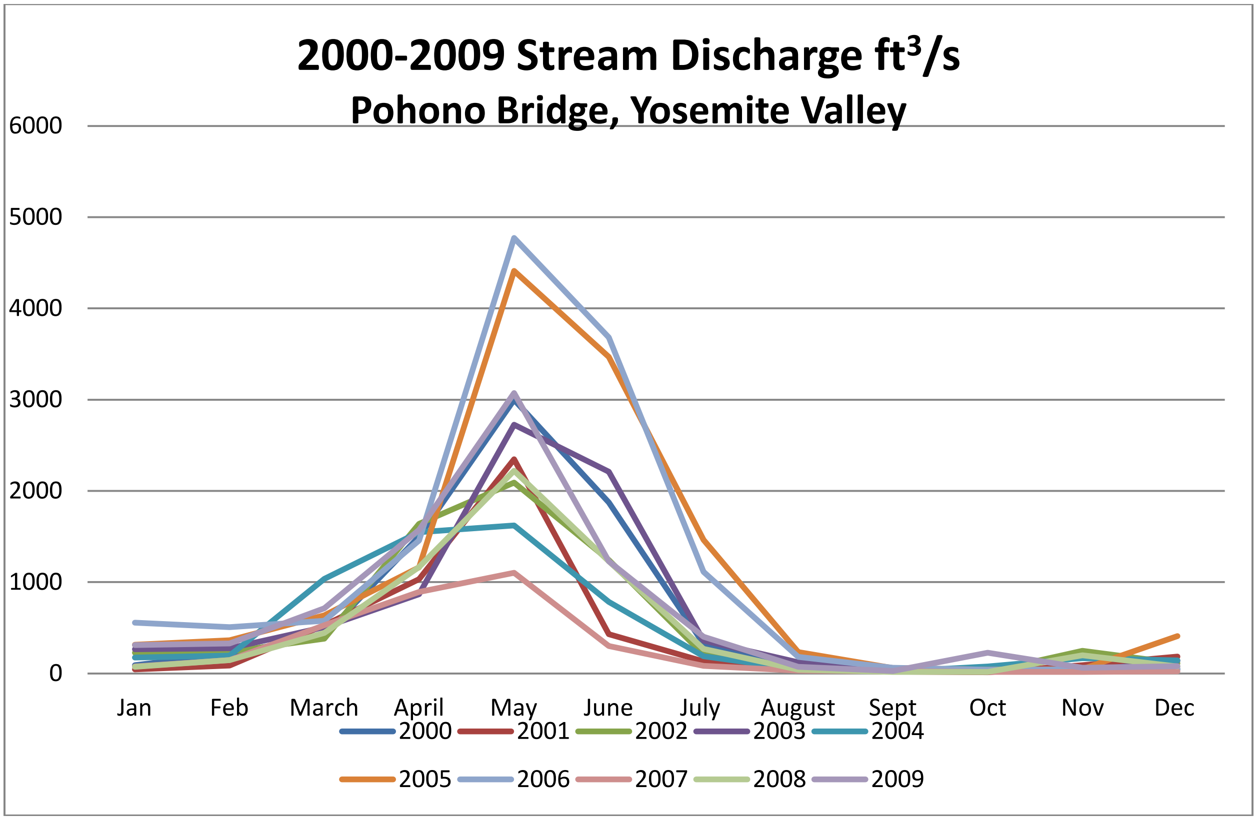
1995
1996
1997
1998
1999


2000-2009 Stream Discharge ft³/s
Pohono Bridge, Yosemite Valley
6000
5000
4000
3000
2000
1000
0
Jan
Feb
March
April
May
June
July
August
Sept
Oct
Nov
Dec
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

Stream Flow Procedure

DEFINITION OF TERMS

Discharge: Another term for stream flow, or the volume of water moving past a designated point over a set period of time.
Flow Regime: The pattern of stream flow over time, including increases with stormwater runoff inputs and decreases to a base-flow level during dry periods.
Impervious Surface: A surface that does not allow water (e.g., rain) to pass through (infiltrate).
Rating Curve: A graphical representation of the relationship between the stage height and the discharge (flow).
Run: An area of a stream that has swift water flow and is slightly deeper than a riffle (a run will be about knee/thigh deep).
Stage Height: Height of the water in a stream above a baseline.
Watershed: An area of land that drains to a main water body.

Why are we concerned?

Stream flow, or discharge, is the volume of water moving past a cross-section of a stream over a set period of time. It is usually measured in cubic feet per second (cfs). Stream flow is affected by the amount of water within a watershed, increasing with rainstorms or snowmelt, and decreasing during dry periods. Flow is also important because it defines the shape, size and course of the stream. It is integral not only to water quality, but also to habitat. Food sources, spawning areas and migration paths of fish and other wildlife are all affected and defined by stream flow and velocity. Velocity and flow together determine the kinds of organisms that can live in the stream (some need fast-flowing areas; others need quiet, low-velocity pools). Different kinds of vegetation require different flows and velocities, too.

Stream flow is affected by both forces of nature and by humans. In undeveloped watersheds, soil type, vegetation, and slope all play a role in how fast and how much water reaches a stream. In watersheds with high human impacts, water flow might be depleted by withdrawals for irrigation, domestic or industrial purposes. Dams used for electric power generation may affect flow, particularly during periods of peak need when stream flow is held back and later released in a surge. Drastically altering landscapes in a watershed, such as with development, can also change *flow regimes,* causing faster runoff with storm events and higher peak flows due to increased areas of *impervious surface.* These altered flows can negatively affect an entire ecosystem by upsetting habitats and organisms dependent on natural flow rates.

Tracking stream flow measurements over a period of time can give us baseline information about the stream's natural flow rate.

Safety considerations

You will need to enter the stream channel to make width and depth measurements and to calculate velocity. Be aware of stream velocity, water depth, and bottom conditions at your stream-monitoring site.

Do not attempt to measure stream flow if water velocity appears to be fast enough to knock you down when you are working in the stream. If you are unsure of water depth across the width of the stream, be sure to proceed with caution as you move across the stream, or choose an alternate point from which to measure stream flow.

Text and images on pages 1 and 2 of this activity are used with permission from the University of Wisconsin Extension and the Wisconsin Department of Natural Resources.

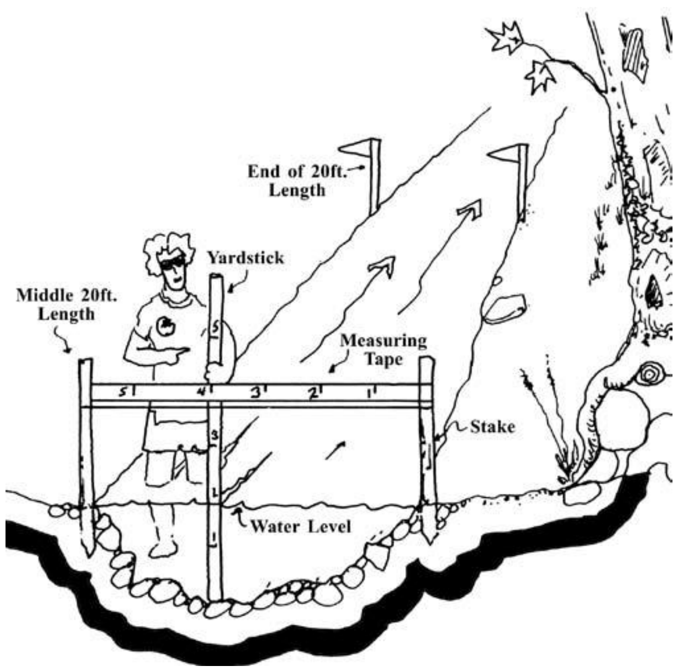
Determining Stream Flow (Area x Velocity = Flow)

The method you are going to use in determining stream flow is known as a velocity-area approach. The task is to find out the volume of water in a 20-ft. (at least) section of stream by determining both the stream's velocity and the area of the stream section. You will first measure the width of the stream, and then measure water depth at a number of locations across the width to find the average depth at your monitoring site. Then by multiplying the average depth by the width, you can determine the average cross-sectional area (ft2) of the stream. Water velocity (ft/sec) is determined simply by measuring the number of seconds it takes a float to travel along the length of stream you are studying. Since water velocity varies at different depths, (surface water moves more quickly than subsurface water because water moving against rough bottom surfaces is slowed down by friction) you will need to multiply velocity by a correction factor to adjust your measurement to account for the effect of friction. The actual equation you will use to determine flow is this: Flow=Area x Corrected Velocity. This method was developed and adapted from several sources (see bibliography). Alternative methods that may be better for your monitoring site are featured in the sidebar below.

Stream Flow Monitoring Methods: Professional and Home-Made

The type of monitoring station used by professionals depends on the conditions at the site including size, slope, accessibility, and sedimentation of the stream. Flow can also be measured at spillways, dams, and culverts or by using a weir or flume, which are man-made structures within a stream that provide a fixed stage-flow relation. Another method, using a home-made combination staff/crest gage, allows volunteer monitors to measure the water level (stage) both at the time of inspection and at the highest level reached since last inspected. This tool is made of PVC pipe, granulated cork and other materials.

For more information, including how to make your own, visit:
www.epa.gov/owow/monitoring/volunteer/newsletter/volmon07no2.pdf



Earth Science Name_________________________ Date__________
Worksheet 5.1—Measuring and Calculating Stream Flow

Measuring and Calculating Stream Flow

Materials

2 flags to mark the start and end of the stream monitoring section
Measuring Tape
Orange or other float device
Appropriate footwear (boots, waders, or water shoes)
Personal Flotation Device (when requested by teacher)
Stopwatch
Calculator

Safety

DO NOT ENTER A STREAM THAT IS MOVING FAST OR IF THE WATER LEVEL IS ABOVE YOUR THIGH. IF AT ANY TIME YOU FEEL YOU MAY LOSE YOUR BALANCE, EXIT THE STREAM.
IF REQUESTED BY YOUR TEACHER, WEAR A PERSONAL FLOTATION DEVICE.
WEAR APPROPRIATE FOOTWEAR IN AND OUT OF THE STREAM.

Procedure

Set-up

1. Locate a straight section of stream at least 20 feet long. Mark the start and end of the length of stream with flags.
2. Measure the width of the stream and record data in Table 1.1
3. Measure the depth (in tenths of an inch) of the stream at 1 foot intervals. Record data in Table 1.2
4. Observe the bottom of the stream. Circle below the best description of the stream bottom.
    1. Rough, loose rocks, coarse gravel, weeds
    2. Smooth mud, sand, bedrock

Measuring Velocity

5. Release your float 3-4 feet upstream of the "Start" flag.
6. Measure the time it takes for the float to travel the distance between flags. *With the students in small groups, have one student in the water ready to release the float object, one on shore watching the starting line, another watching the finish line, one using the stop watch, and all others in the water behind the finish line to catch the object.* Only time the distance between flags. Record in data Table 1.1
7. Repeat step 4 and 5 at three additional locations across the stream. Record data in Table 1.1

Data and Calculations

Table 1.1

	Width of Stream	Float Distance Measured	Time to travel distance
Location 1			
Location 2			
Location 3			
Location 4			
		Average Travel Time	

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Earth Science Name___________________________ Date__________

Worksheet 5.1—Measuring and Calculating Stream Flow

Table 1.2

Depth 1	Depth 2	Depth 3	Depth 4	Depth 5	Depth 6	Depth 7	Depth 8	Depth 9	Depth 10	Average Depth

Multiply the average depth of the stream by the width of the stream to find the **area** in ft^2.

Divide the distance traveled by the average travel time to find the **velocity of the stream** in ft/sec.

Multiply the velocity of the stream by a correction factor. This is the **corrected velocity** of the stream.

> Choose a correction factor of 0.8 for stream bottoms with rocks, loose gravel, coarse gravel, or weeds.
>
> Choose a correction factor of 0.9 for stream bottoms with smooth mud, sand, or bedrock.

Multiply the corrected velocity of the stream by the area of the stream to obtain ft^3/sec. This is the measure of stream flow in cubic feet per second!

Conclusion

Based on your data analysis, write a conclusion for this activity.

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Virtual Field Trip Procedure

- ☐ **Contact park at least 2 month prior to your program.**
- ☐ **Discuss topic and desired content with park staff.**
- ☐ **Make sure that either Google Plus or Skype are set up on your computer.**
- ☐ **Double check contact information for park's account and that both parties have added each other prior to the session.**

Google Plus

Open Google email: make sure that you have sent an email back and forth with the teacher. Go to the "search people" box right above your contacts and search for the name of the teacher. Once found, move your mouse over the name and select the option to "show in chat list." You will then have to click on "invite to chat" in the same window. The teacher on the other end has to accept your chat invitation before you can video call them. They will get an announcement right above their contact list saying "____ wants to be able to chat with you. Okay? Yes/no."

Place call to audience: click on the name of the user in your contact list and a small chat window will pop up at the bottom of your screen. In this window, you'll have an option to click on the video camera to send a video chat request.

Skype

Open Skype: Double-click on the Skype icon. Enter your user id and password at the applicable prompts.

Make sure you are online: You will see a green circle with a checkmark as well as the word "online" in the lower left corner of the Skype window.

Place Call to Audience: To connect with a Skype user, either double-click on the user name or highlight the user name and click the green telephone icon on the bottom of the window.

Start Video: When the person answers the Skype call, "Start my Video" so that the user can see your video.

Using Chat: Place your cursor in the text box at the bottom of the chat window and start typing your message; then click "Enter" on your keyboard. You will then see your chat message display under a gray heading. The person on the other end will reply and their text will display under a blue heading. The chat feature is very useful if you are having microphone issues as you can communicate with the user via text.

Test video: Once you are sure that your audio is working properly, make sure that your video is working.

Select Tools -> Options -> Video Settings and you should see your video on the right side of the window.

Test your audio: Once you are online, ensure that your headset/microphone is working properly. Double click on the "Skype Test Call" and follow the automated operator's instructions. You can then adjust volume and re-test (if necessary).

If your audio is not working, open the Tools->Options->Audio Settings in the Skype window. Ensure that the microphone is the "Windows Default Device"; then, click "Save". If your audio is still not working, reboot your computer. Upon rebooting, you may see a screen that requires you to select "microphone" and then click on "Okay." You can now re-test your audio.

Climate Change Project Assignment

Imagine you are a scientist studying regional climate change in the Eastern Sierra. You have to present your findings to your peers and make predictions about the future. You have complete creative freedom to decide how you will present your findings. In the past, scientists have used essays, brochures, presentation software, videos, and science presentation boards. One of these options would be a good possibility.

Assignment:
Demonstrate mastery of your understanding of the effects of climate change through completion and presentation of a project.

Your project must include:

1. Evidence for local climate change.
2. Your lab report from the stream assessment activity.
3. A connection to the larger community, i.e. how climate in the Eastern Sierra affects California, United States, and the world.
4. Your prediction of potential consequences if the climate continues to change at its current rate.
5. A section presenting “What you can do” to minimize the negative effects of climate change.
6. A 5 minute presentation to your peers.

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Project Rubric

	4- Meets all expectations	3- Meets most expectations	2- Fails to meet some expectations	1- Does not meet expectations
Format	▪ Includes at least 5 appropriate pictures, charts, graphs, or tables. ▪ Includes 1-2 page written abstract.	▪ Includes less than 2-4 pictures, charts, graphs, or tables. ▪ Written abstract is ¾ -1 page in length.	▪ Includes 1 picture, chart, graph, or table. ▪ Written abstract is less than ¾ of a page.	▪ Fails to include pictures, charts, graphs, or tables. ▪ Fails to include a written abstract.
Presentation	▪ 4-6 minutes long. ▪ Appropriate presentation method chosen. ▪ Maintain eye contact where appropriate.	▪ 2-4 minutes long ▪ Appropriate presentation method chosen. ▪ Occasionally fails to make eye contact.	▪ 1-2 minutes long ▪ Fails to choose appropriate presentation method. ▪ Occasionally makes eye contact	▪ Presentation is less than 1 minute. ▪ Fails to choose appropriate presentation method. ▪ No eye contact.
Evidence for climate change	▪ Accurate climate science is included. ▪ Conclusions are based on climate science data.	▪ There are 1 or 2 minor inaccuracies in climate science data. ▪ Conclusions are not based on the included data	▪ There are multiple inaccuracies in climate science data. ▪ Conclusions are not based on any data	▪ Climate science data is wrong or omitted. ▪ Conclusions are missing.
Lab report	▪ Includes Introduction, Hypothesis, Materials and Methods, Data and Analysis, Results, and Conclusion.	▪ Missing 1 section of the lab report	▪ Missing 2-3 sections of the lab report	▪ Lab report is incomplete or omitted.
Local to global connections	▪ Clear connections are mad between local, regional, and global climatology and environment.	▪ Clear connections are made but local, regional, or global is omitted.	▪ Local connections are omitted.	▪ Local, regional, and global connections are omitted.
Predictions and suggestions	▪ Predictions are based on multiple pieces of evidence from current data. ▪ Suggestions for "What can you do?" could minimize the negative effects of predictions.	▪ Predictions are based on 1 piece of evidence. ▪ 1 suggestion for "What can you do?" to minimize the effects of climate change predictions.	▪ Predictions are not based on data from the project. ▪ Suggestion does not relate to the negative effects of climate change predictions.	▪ Predictions are not related to climate change. ▪ No suggestion is made for "What can you do?" to minimize the negative effects of climate change predictions.

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Earth Science
Vocabulary

1. geosphere – layer of Earth under both atmosphere and oceans; It is composed of the core, the mantle, and the crust.
2. hydrosphere – the water portion of Earth
3. biosphere – all life on Earth; the parts of the solid Earth, hydrosphere, and atmosphere in which living organisms can be found.
4. atmosphere – the gaseous portion of a planet; the planet's envelope of air
5. geoscience – the sciences that deal with the earth
6. climate – the average course or condition of the weather at a place usually over a period of years as exhibited by temperature, wind velocity, and precipitation
7. weather – the state of the atmosphere with respect to heat or cold, wetness or dryness, calm or storm, clearness or cloudiness
8. climate change – any significant change in the climate lasting for decades or longer
9. habitat – an ecological areas that is inhabited by a particular species because they are able to find everything that they need to survive (food, water, shelter, and space)
10. ecosystem – a community of living organisms (biotics) in conjunction with the non-living components (abiotics) of their environment
11. arable land – land that can be used for growing crops
12. positive feedback loop – the process in which the effects of a disturbance on a system cause an increase in the magnitude of the disturbance
13. negative feedback loop – the process in which the effects of disturbance on a system decrease its magnitude
14. coevolution – the change in one biological object triggered by the change of a related object
15. natural resources – materials and components that can be found within the environment
16. fossil fuels –
17. renewable resources – a natural resource that can be replenished over time either through biological reproduction or other naturally occurring processes
18. nonrenewable resources – a resource that does not renew itself at a sufficient rate for sustainable economic extraction in meaningful human timeframes
19. irreplaceable resources – a resource that can't be replaced

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Earth Science
Vocabulary

20. photosynthesis – a process used by plants and other organisms to convert light energy, from the sun, into chemical energy that can be used to fuel the organisms' activities

21. cellular respiration – the biochemical pathway by which cells release energy from the chemical bonds of food molecules and provide that energy for the essential processes of life.

22. biomass – biological material derived from living, or recently living organisms

23. carbon cycle – the biochemical cycle by which carbon is exchanged among the biosphere, pedosphere, geosphere, hydrosphere, and atmosphere of the Earth

24. biodiversity – the degree of variation between of life forms within a given species, ecosystem, biome, or planet

25. adaptation – the ability of a species to survive in a particular ecological niche, especially because of alterations of form or behavior brought about through natural selection

26. orbit – the gravitational curved path of an object around a point in space

27. axis of rotation – a circular movement of an object around a center of rotation

28. temporal scales – time scale

29. spatial scales – space scale

30. local – community in an immediate area

31. regional – clusters of like areas based on physical characteristics

32. global – the Earth as a whole

33. latitude – a geographic coordinate that specifies the north-south position of a point on the Earth's surface

34. geography – the study of lands, inhabitants, and the phenomena of the Earth

35. greenhouse effect – a process by which thermal radiation from a planetary surface is absorbed by atmospheric greenhouse gases, and is re-radiated in all directions

36. absorption – a physical or chemical phenomenon or a process in which atoms, molecules, or ions enter some bulk phase- gas, liquid, or solid material

37. reflection – the change in direction of a wavefront at an interface between two different media so that the wavefront returns into the medium from which it originated

38. transmission – the act of passing something on in another place

39. redistribution – to relocate

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40. thermal capacity – the quantity of heat necessary to produce a unit change of temperature in a unit mass of a substance
41. deduce – to arrive at a fact or conclusion by reasoning
42. infer – deduce or conclude information from evidence and reasoning rather than from explicit statements
43. predict – to foretell on the basis of observation, experience, or scientific reason
44. pattern – to repeat
45. model – a small object, usually built to scale, that represents in detail another, usually larger object
46. watershed – an area of land where all of the water that is under it or drains off of it goes into the same place
47. solar output – the amount of radiation emitted by the sun
48. snowpack – forms from layers of snow that accumulate in geographic regions and high altitudes where the climate includes cold weather for extended periods of time throughout the year
49. snow-water equivalent – the amount of water contained within the snowpack

Student Evaluation

Student Name

____

Teacher Name

____

Class or Section
___ Period 1
___Period 2
___Period 3
___Period 4
___Period 5
___Period 6

This unit was directly related to our course curriculum.
(1-strongly disagree, 4-strongly agree)
1 2 3 4

I learned new information about climate change.
1 2 3 4

The unit was relevant to my life.
1 2 3 4

My teacher explained necessary vocabulary so I could understand the content.
1 2 3 4

There were enough hands-on activities in this unit.
1 2 3 4

The hands-on activities in this unit were directly related to the content we studied.
1 2 3 4

I can now use stream flow data to provide evidence for climate change.
1 2 3 4

I could safely measure stream flow without assistance from a teacher.
1 2 3 4

I can explain to friends and family how National Parks are “science labs” for climate change.
1 2 3 4

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Earth Science
Student Evaluation

I have a better understanding of Devils Postpile National Monument.
1 2 3 4

This unit has increased my interest in National Parks.
1 2 3 4

I now know about climate science measurements in at least one other National Park.
1 2 3 4

The onsite visit to Devils Postpile was educational and clearly connected to the content in this unit.
1 2 3 4

I would recommend this unit to be taught to other classes similar to mine.
1 2 3 4

This lesson was created for the Teacher-Ranger-Teacher program through the National Park Service.

Teacher Evaluation

Teacher Name:____

Grade:______________________ School:_____________________________

Mark one per row.

	Highly (4) Effective	Effective (3)	Developing (2)	Ineffective (1)
Lesson Plan	Creative, relevant, builds knowledge base, includes all essential elements	Useful activities, objectives, etc	Missing one element	Missing essential elements
Standards Correlation	Standards-born lesson incorporating common core standards for science	Connects to skills in science common core standards	Missing parts of the common core standards	Does not correlate to standards
Materials	Above and beyond needed materials	Sufficient materials	Most required materials available	Some materials needed
Reaching toward unit objectives	Lessons directly promote skills and understanding linking to unit	Lessons promote some unit skills	Lessons promote learning but not necessarily in relation to unit objectives	Does not tie into unit goals

1-strongly disagree 4-Strongly agree

This unit was grade-level appropriate.

1 2 3 4

The unit aligns with the science common core standards.

1 2 3 4

Within the lesson plans, the objectives were clear.

1 2 3 4

Within the lesson plans, the procedure was clear and easy to follow.

1 2 3 4

Students were receptive and enjoyed the unit.

1 2 3 4

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Earth Science
Teacher Evaluation
I would be interested in having Devils Postpile National Monument mail me the needed materials, even if I had to pay my own postage to send it back.
1 2 3 4
Which parts of the unit were the most useful?

Which parts of the unit did you use?

What did you like least from the unit?

What other resources could help make this unit work?

What was the most effective part of this lesson?

What would you change or improve upon if you taught this again?

How did you receive feedback from students? (Used student evaluations, took a class poll, etc)

Comments:

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